NASA TECH BRIEF

Buckling of Shells of Revolution (BOSOR) with Various Wall Constructions

The problem:

The necessity of performing stability analyses for a wide class of shells without unduly restrictive approximations.

The solution:

A computer program which uses numerical integration and finite difference techniques to solve with reasonable accuracy almost any buckling problem for shells exhibiting "orthotropic behavior". For this type of shell in the prebuckling state, axisymmetrical loads produce axisymmetrical displacements.

How it's done:

For the geometry of the meridian, the general branch of the program calls for input in the form of cartesian coordinates for a number of points along the meridian. Special branches are provided for cylindrical, conical, spherical and toroidal shells.

The general branch for the shell wall stiffness data calls for input in the form of coefficients of the constitutive equations. Special branches calling for simpler input data are provided for: shells with ring and stringer stiffening; shells with skew stiffeners; fiber reinforced shells; layered shells; corrugated ring stiffened shells; and shells with one corrugated and one smooth skin. The stiffness coefficients must be constant along the meridian.

The most general form of the boundary conditions for the prebuckling analysis is a set of four nonhomogeneous equations containing twenty coefficients. For the stability analysis, the homogeneous boundary conditions consist of eight equations and sixty-four coefficients which are called for as input by the general branch. The boundary conditions can be calculated internally (with only control integers required as input) by several provided branches which include force or displacement boundary conditions, support by elastic edge rings or support by an elastic medium. The shell can be opened or closed at the apex.

In the first part of the analysis, the Newton-Raphson procedure is used to solve the set of nonlinear algebraic equations. These equations result from a finite-difference analog of the nonlinear, nonhomogeneous, second-order ordinary differential equations governing the prebuckling state of the shell. The solution of the equations yields the prebuckling meridional rotation and meridional and circumferential stress resultants.

The second part of the analysis solves the stability equations (Donnell type formulation) which are linear, homogeneous, fourth-order, partial differential equations. Since the dependent variables are harmonic, dependence on the circumferential coordinate can be eliminated and the resulting ordinary differential equations solved by the method of finite differences. The stability analysis is formulated as an eigenvalue problem with the lowest eigenvalue of the stability equations corresponding to the critical load.

Notes:

1. This program is written in FORTRAN IV for use on the UNIVAC 1108 computer.
2. Inquiries should be made to:
   COSMIC
   Computer Center
   University of Georgia
   Athens, Georgia 30601
   Reference: B69-10300

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

Source: D. Bushnell, B. O. Almroth and L. H. Sobel of
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